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Connecticut Inland Fisheries

Bass Research and Management

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Bureau of Natural Resources
Inland Fisheries Division

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Job 3: Bass Research and Management
Job 4: Bass Supplemental Stocking Study

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Cover photo: Smallmouth Bass. Photo by Robert Jacobs.

Summary

Largemouth bass from a public lake (Mansfield Hollow Reservoir) were transplanted to another public lake (Gardner Lake) in 2014 to serve as an experimental "control" for previous transplantations of bass from unfished water supply reservoirs. Electrofishing and tournament weigh-in monitoring conducted at Gardner Lake in 2014 revealed that public lake transplants were no more susceptible to angling than resident fish and persisted throughout the open water fishing season. These results contrasted markedly with those obtained by transplanting bass from an unfished reservoir to Gardner Lake in 2013 when reservoir transplants displayed high initial vulnerability to angling and largely disappeared by the conclusion of the 2013 fishing season. Results of the 2014 transplantation experiment refute the hypothesis that transplanted bass, regardless of source population, experience high mortality due to failure to acclimate to a new environment, and further bolster the hypothesis that hooking mortality is the most likely explanation for the observed failure of highly susceptible reservoir transplants to persist in the public lakes.

Background

Largemouth and Smallmouth Bass combined are Connecticut's most popular gamefish (U.S. Fish and Wildlife Service 2011). In recent decades, interest in bass fishing and the sophistication of bass angling techniques have both increased. In addition to their recreational importance, bass are the principal predatory fish in nearly all of the state's lakes and ponds and thus play a key role in maintaining predator-prey balance in complex fish communities.

Bass management nationwide has typically focused on the use of alternative length and possession limits to enhance bass populations (Lundquist 1990, Mosher 1991). These management practices have historically been successful in improving the abundance of large bass in Connecticut lakes (Jacobs et al. 1995). However, more recent applications have produced mixed results (Jacobs et al. 2011). In 2002, 29 Bass Management Lakes (BMLs) were established with conservative length and possession limits. Densities of quality size (≥12-inch) bass increased in some lakes, but were unchanged or decreased in others after the alternative regulations were applied. The primary reason that the additional protection via conservative length limits had negligible effect is that increasing numbers of anglers are releasing all the bass they catch regardless of size (Jacobs et al. 2011), thus rendering harvest restrictions increasingly irrelevant. Given the apparent inadequacy of traditional management methods to enhance

Connecticut bass populations, it has become important for fisheries managers to investigate new management strategies.

Numerous recent studies have shown that harvest by humans can result in genetic changes in fish populations, a phenomenon referred to as “Fisheries Induced Evolution” (Law 2007). Research on Largemouth Bass has shown that physiological and behavioral traits, such as metabolism, vulnerability to angling, boldness and aggressiveness are heritable – i.e. they have a genetic basis (Burkett et al. 1986, Cooke et al. 2007, Philipp et al. 2009). By selectively removing fish with these traits, harvest and angling-related mortality have the potential to change the “natural” genetic makeup of bass populations.

Stocking bass from unfished reservoirs into public lakes has potential to improve bass populations. IFD file photo.

Connecticut is uniquely positioned to investigate the potential evolutionary impacts that angling has had on bass populations because it is one of the few states in the country where fishing is not allowed in most of its water supply reservoirs. These reservoirs provide a rare opportunity to study fish populations unaffected by angling. Previous assessments revealed that Connecticut reservoirs generally contain higher densities of large, faster-growing bass than do public lakes (Jacobs and O’Donnell 1996). Differences in bass behavior were also evident as Largemouth Bass were four times and Smallmouth Bass ten times more vulnerable to experimental angling in the unfished reservoirs than in public lakes. It is possible that disproportionate harvest and/or hooking mortality of aggressive bass (which are the easiest to catch) has altered the gene pool of bass populations in public lakes, resulting in populations dominated by fish that are less aggressive, bold and active. It is therefore plausible that the observed differences between reservoir and public lake bass populations in Connecticut reflect genetic divergence of these populations.

The availability of innately bold and aggressive bass has considerable potential to improve bass populations in Connecticut. It is possible that infusing bass populations in public lakes with genes of bass from unfished reservoirs via periodic supplemental stockings could improve bass fishing, and could also improve ecosystem balance by increasing predation on overabundant panfish species. The Connecticut Department of Energy and Environmental Protection Inland Fisheries Division (IFD) therefore has an opportunity to initiate a unique remediation of the undesirable effects of Fisheries Induced Evolution.

A cooperative "Bass Supplemental Stocking Study" was initiated in 2011 to further investigate the potential utility of unfished reservoir bass populations for improving bass fishing in Connecticut public lakes. Two distinct sub-studies will be conducted as part of this Job. **Sub-Study A** will assess genetic and physiological differences between fished and unfished Largemouth Bass populations in Connecticut. This sub-study has been contracted out to the University of Connecticut (UConn) Department of Natural Resources and the Environment. Progress on this sub-study will be reported annually by UConn and attached as Appendix 1 to this document. **Sub-Study B** entails experimental stocking of public lake fisheries with catchable size reservoir bass. This sub-study will be conducted by IFD and UConn.

This report details the work accomplished between April 2014 and March 2015 for Job 3 (Bass Research and Management) and Job 4-Sub-study B (Bass Supplemental Stocking Study).

Approach

Bass Research and Management

Bass Population Estimates

A Schnabel mark-recapture estimate (Hayes et al. 2007) of bass population size was obtained for Gardner Lake during 2014. Bass were marked through multiple nights of boat electrofishing and recaptures were recorded at bass tournament weigh-ins.

Bass Supplemental Stocking Study: Sub-Study B

Sub-Study B entails transplantation of Largemouth Bass from unfished water supply reservoirs into public lakes (bass transplanted from unfished reservoirs are subsequently referred to as "reservoir transplants" in this report). In 2012, reservoir transplants were obtained from Reservoir 1 and stocked into Mansfield Hollow Reservoir (Davis et al. 2013; note that Mansfield Hollow is a flood control reservoir that is open to fishing, not a water supply reservoir). In 2013, reservoir transplants were obtained from Reservoir 2 and stocked into Gardner Lake (Davis et al. 2014). In 2014, bass were transplanted from Mansfield Hollow Reservoir to Gardner Lake. The 2014 transplantation of public lake bass ("public lake transplants") to another public lake was intended to provide a "control" for the reservoir transplantation experiments conducted in 2012-13 – i.e. to provide insight into whether the observed behavior and persistence of reservoir transplants was simply attributable to their displacement into a different lake. All transplanted bass were collected using boat electrofishing, and transported in insulated tanks mounted in pickup trucks. Two tank sizes – 169 and 58 gallons – were loaded with a maximum of 115 or 40 bass, respectively. An oxygen diffuser system was used to maintain dissolved oxygen levels in transport tanks. All transplanted bass were stocked into recipient lakes on the same night of collection, and were given a distinctive fin clip to allow future identification. Mortality immediately following transplantation was assessed and found to be negligible in 2012 (Davis et al. 2013).

The persistence of public lake transplants in Gardner Lake during 2014 was monitored by electrofishing the lake during the spring and fall (electrofishing does not effectively sample bass during summer).

Almost all bass tournament weigh-ins held at Gardner Lake in 2014 were monitored to assess tournament angler catch rates (fish caught per hour of fishing time, or CPH) of resident bass vs. transplants. All bass brought to weigh-ins were examined for fin clips, measured to the nearest cm and released. Tournament participants were also asked how many bass greater than 12 inches they released (culled) during their day's fishing.

Bass Supplemental Stocking Study: Sub-Study A

Approach for Sub-Study A is described in Appendix 1.

Key Findings

Bass Research and Management

Bass Population Estimates

Population estimates of Largemouth and Smallmouth Bass were obtained at Gardner Lake during the spring of 2014 (Table 1). Bass population sizes in Gardner Lake have been relatively stable over the last five years.

Table 1. Population estimates for quality size (≥12-inch) resident Largemouth and Smallmouth Bass at Gardner Lake during 2009-14.

Year	Species	Pop Size (No. of fish)	95% CI	Density Bass/Acre	R[1]
Spring 2009	Largemouth	1,229	826 – 1,830	2.3	24
	Smallmouth	259	175 – 383	0.5	25
Spring 2013	Largemouth	1,497	1,129 – 1,985	2.8	48
	Smallmouth	325	165 – 644	0.6	8
Spring 2014	Largemouth	1,370	954 – 1,969	2.6	29
	Smallmouth	308	104 – 923	0.6	3

[1] R is the number of marked fish that were recaptured. Higher numbers of recaptures results in more precise estimates of population size.

Bass Supplemental Stocking Study: Sub-Study B

Fish Transplantation

During three nights in early April 2014, 201 quality size (≥12 inches) Largemouth Bass were collected from Mansfield Hollow Reservoir via boat electrofishing and transferred to Gardner Lake. Bass were held a maximum of seven hours in oxygenated tanks before being stocked. IFD staff visually inspected bass for signs of stress immediately before stocking; all fish appeared to be in good condition.

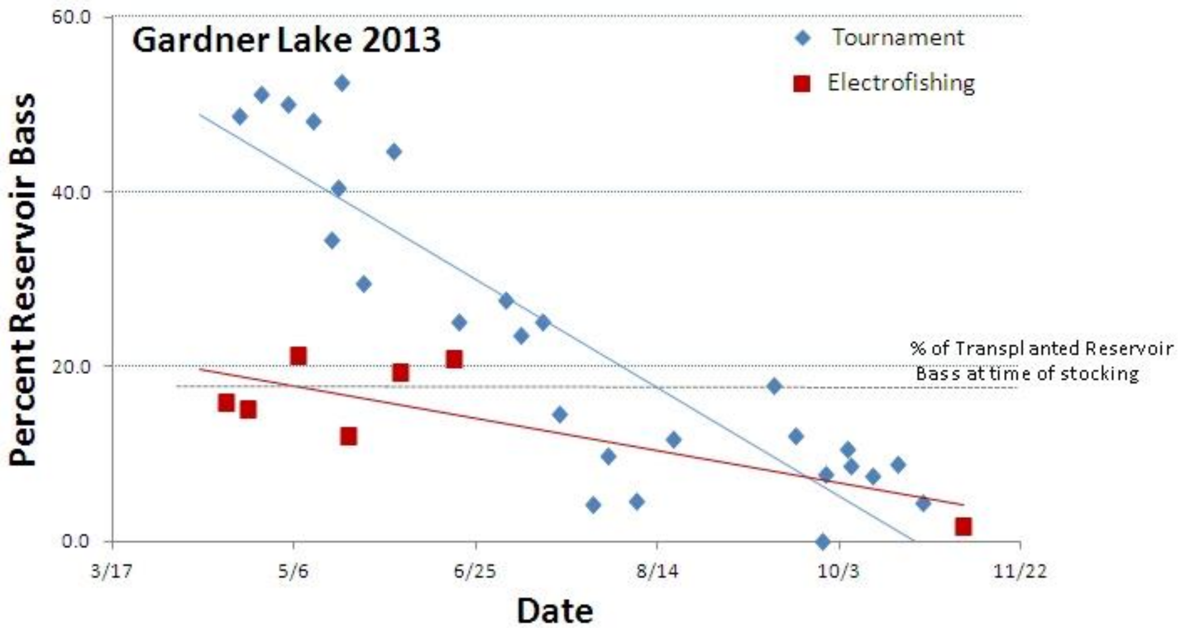
Gardner Lake Experiment

The population of resident quality size Largemouth Bass in Gardner Lake in spring 2014 was an estimated 1,370 fish (Table 1), indicating that the 201 public lake transplants comprised approximately 12.8% of the overall (resident plus transplant) quality size bass population in the lake at the onset of the 2014 fishing season.

The entire shoreline of Gardner Lake was electrofished on eight nights in 2014; five during the spring and three during the fall at approximately one-week intervals. There was no trend in percentage of public lake transplants in electrofishing catches over the season (Fig. 1). In general, the percentage of public lake transplants in electrofishing samples was similar to their estimated percentage in the population at time-of-stocking. These results stand in contrast to those observed in 2013, when reservoir transplants largely disappeared from electrofishing samples by the conclusion of the fishing season (Fig. 1).

Twenty-nine bass tournament weigh-ins were monitored at Gardner Lake from April 26 to October 19, 2014. As in the electrofishing samples, there was no detectable trend in the percentage of public lake transplants in tournament catches at Gardner Lake across the 2014 fishing season (Fig. 1). In contrast, the percentages of reservoir transplants in tournaments at Gardner Lake in 2013 were initially much higher than their estimated percentage in the population at time-of-stocking and then declined markedly over the course of the fishing season (Fig. 1).

Average catch rates of Largemouth Bass by tournament anglers for the entire fishing season were similar between 2013 (0.43 fish/hr) and 2014 (0.40) when considering only fish brought to weigh-ins. However, when culled fish were included in catch rate calculations, it was apparent that tournament angler catch rates were higher in 2013 (0.89) than 2014 (0.63). A marked difference was apparent in seasonal trends of transplant catch rates (when considering fish brought to weigh-ins only; it was not possible to determine whether culled fish were residents or transplants). The catch rates of public lake transplants (green portion of stacked bars in Fig. 2) were relatively consistent throughout the 2014 fishing season, ranging from 0.07/hr to



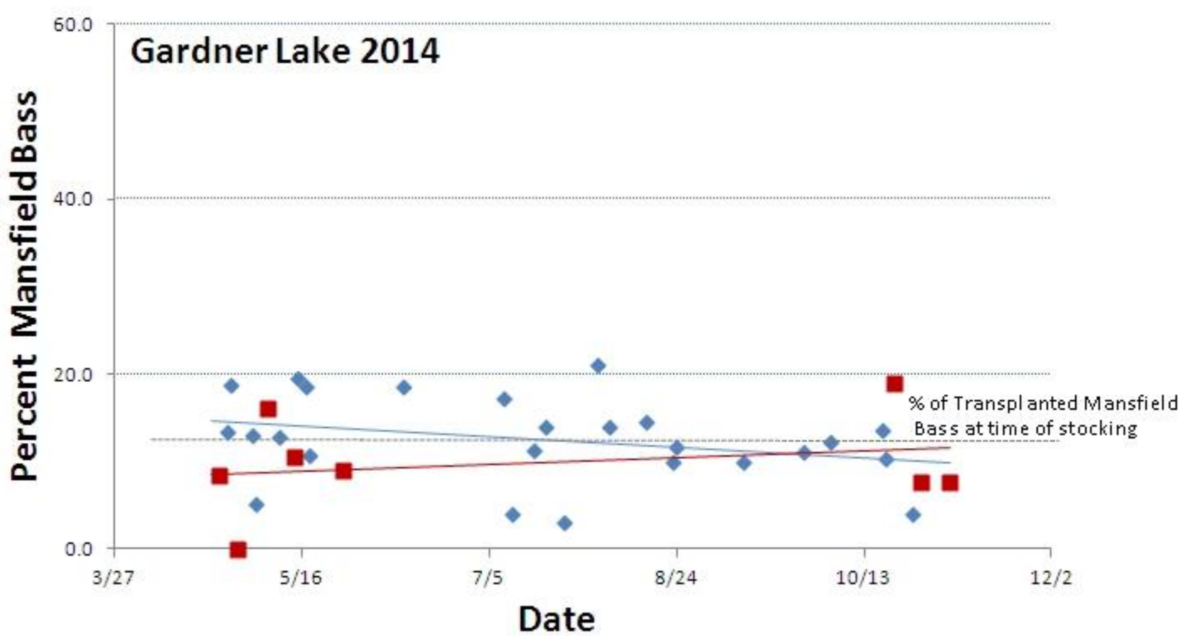


Figure 1. *Percent of reservoir transplants (2013) and public lake transplants (2014) in electrofishing and tournament catches of quality size (≥12 inches) bass during the open water fishing season (April-October) at Gardner Lake. Each tournament data point represents an individual tournament; each electrofishing data point represents an entire lap of the lake. Trend lines correspond to data points of similar color. The horizontal dashed line represents the percent (2013: 21.6%; 2014:12.8%) of transplanted bass in the population at time-of-stocking.*

0.03/hr. Conversely, catch rates of reservoir transplants in 2013 (red portion of stacked bars in Fig. 2) were highest in April (0.30/hr) and declined each month to a low of 0.03/hr.

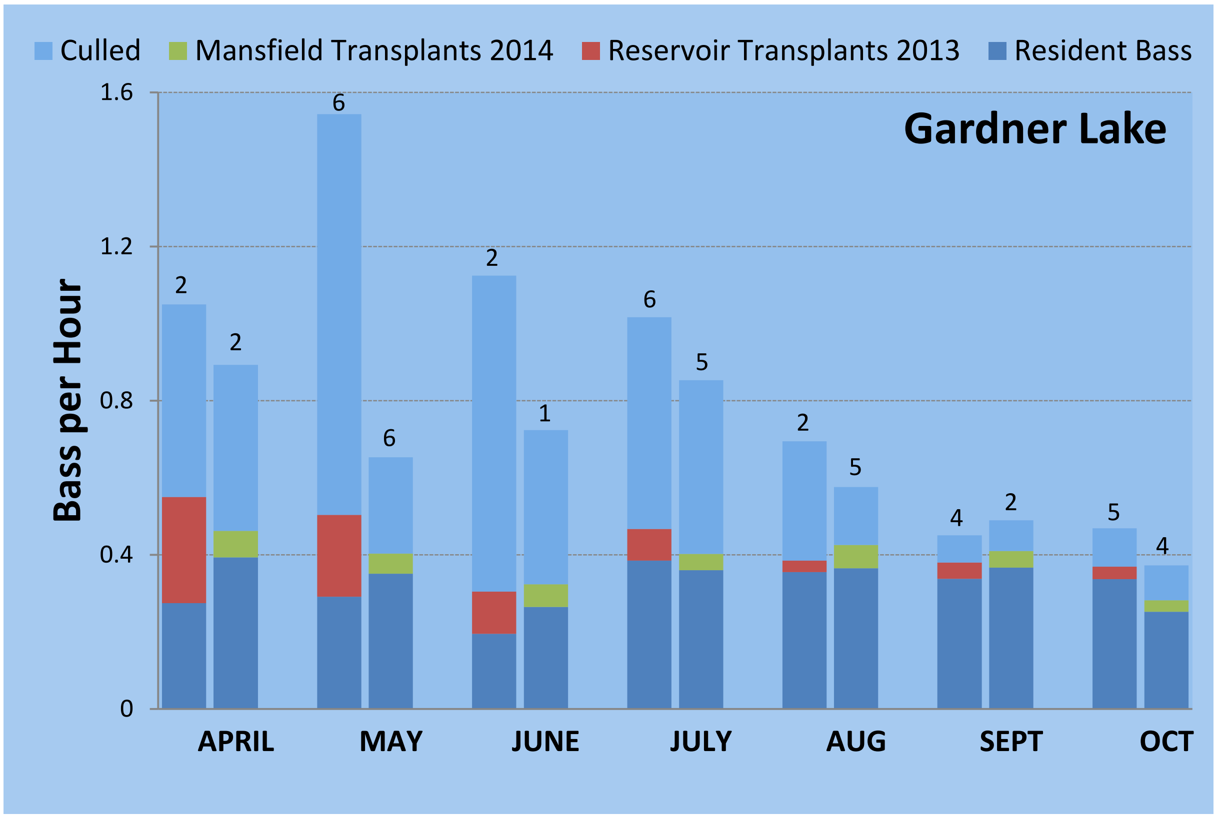


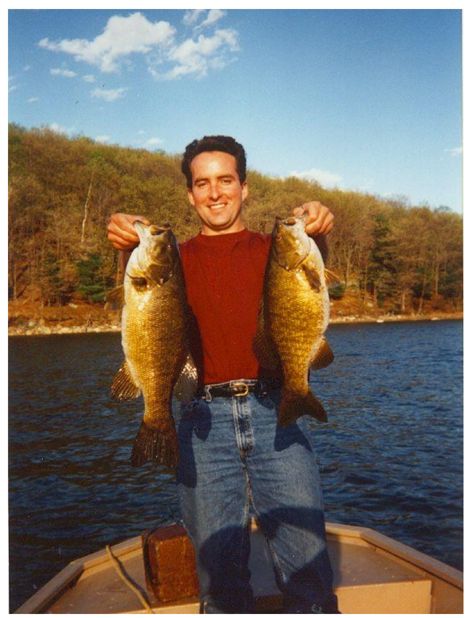
Figure 2. *Tournament monthly average catch rates of Largemouth Bass (of fish brought to weigh-in) from Gardner Lake during 2013 and 2014. Catch rates for fish brought to weigh-ins are separated into those of reservoir transplants vs. resident bass in 2013 and public lake transplants vs. resident bass in 2014. The number on tournaments monitored in each month is shown at the top of each bar. The gray bars at the top of each stack represent the reported culling rates of bass ≥12 inches; it is unknown whether these fish were resident bass or transplants.*

Bass Supplemental Stocking Study: Sub-Study A

Key findings of Sub-Study A are reported in Appendix 1.

Discussion

The transplantation of public lake bass to Gardner Lake in 2014 provided valuable insight into the results of the previous transplantation experiment conducted at this lake in 2013 (Davis et al. 2014). In 2013, bass from an unfished reservoir were transplanted to Gardner Lake prior to the onset of the open water fishing season. These reservoir transplants were much more susceptible to angling than resident fish, as evidenced by their disproportionately high (i.e. much higher than their percentage in the population) occurrence in tournament catches during the early portion of the fishing season. However, the percentages of reservoir transplants in tournament catches declined over the course of the fishing season. Learned hook avoidance may have played some role in declining catches of reservoir transplants; indeed, the results of a controlled angling experiment conducted by UConn in 2014 suggests that bass may rapidly learn to avoid lures after repeated exposure to them (see Appendix 1). High mortality of reservoir transplants also contributed to declining catches, a fact made evident by fall 2013 electrofishing samples which revealed that only a small number of transplants remained in the lake. We discounted emigration and harvest as significant contributors to the disappearance of reservoir transplants as there is no appreciable outlet from Gardner Lake and estimated harvest rates from angler surveys were low (Davis et al. 2014). We concluded that the two most likely explanations were high hooking mortality, or high mortality resulting from failure of transplanted fish to acclimate to a new environment (Davis et al. 2014). The 2014 transplantation experiment at Gardner Lake was conducted to test the "acclimation failure" hypothesis.



Geoff Gratton with two Smallmouth Bass sampled from one of the unfished reservoirs.

The results of the 2014 transplantation of public lake (Mansfield Hollow) bass to Gardner Lake did not support the hypothesis that transplanted bass are likely to experience high mortality regardless of source population. Unlike reservoir transplants in 2013, public lake transplants in 2014 persisted throughout the fishing season. Their persistence, coupled with the fact that, unlike 2013 reservoir transplants, public lake transplants were not highly vulnerable to angling and therefore did not likely experience a high number of catch events in the immediate post-stocking period, further bolsters the hypothesis that hooking mortality is the most likely explanation for the rapid disappearance of 2013 reservoir transplants. Analyses underway at UConn of the number of times that individual public lake transplants were caught at 2014 Gardner Lake tournaments will provide further insight into the relative angling vulnerability of reservoir transplants vs public lake transplants (see Appendix 1). Population modeling is one possible avenue for further testing the hooking mortality hypothesis. Modeling exercises can draw upon data collected during this study on relative vulnerability of reservoir transplants, as well as data previously collected by IFD on bass hooking mortality rates (Edwards et al. 2004).

Recommendations

- Conduct population modeling to determine if hooking mortality can explain the decline of reservoir transplants at Gardner Lake in 2013.

Expenditures

Bass Research and Management

Total Cost: ???????
Federal Share:
State Share:

Reservoir Bass Studies

Total Cost:
Federal Share:
State Share:

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Appendix

Appendix 1. Progress report for Job 4-(Bass Supplemental Stocking)-Sub-Study A the assessment of the genetic and physiological differences between fished and unfished Largemouth Bass populations in Connecticut.

PROGRESS REPORT

Project Title: Comparisons of fished and unfished Largemouth Bass populations: metabolism, angling vulnerability, and the potential for mitigative supplemental stocking.

March 6th 2015

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Background

The Connecticut Department of Energy and Environmental Protection (DEEP) funded a study entitled "Comparisons of fished and unfished Largemouth Bass populations: metabolism, angling vulnerability, and the potential for mitigative supplemental stocking." This project has three primary objectives: (1) compare bass tournament catch rates between an unfished population of bass stocked into public lakes and the resident fished populations, objective 1 is hereafter referred to as the tournament experiment. (2) compare genetic introgression of an unfished population of bass stocked into a small public lake with the introgression of a fished population stocked into the small public lake, hereafter referred to as introgression experiment. Additionally this objective will evaluate the potential of stocked fish to improve recreational catch rates. (3) evaluate differences in basal metabolic rate and angling vulnerability of unfished and fished populations of bass raised in a common environment, hereafter common garden experiment. This progress report summarizes project updates, initial sampling and preliminary results for objectives one, two and three conducted from February 2014 to January 2015, and remaining outstanding analyses.

Field, Laboratory, and Analysis Methods

Objective 1: Compare bass tournament catch rates between unfished populations of bass stocked into public lakes and resident fished populations

Spring, summer and fall tournaments were monitored in Gardner Lake during the 2014 tournament season in a method consistent with those described in past progress reports for the 2013 (Mansfield Hollow Reservoir and Gardner Lake) and 2012 (Mansfield Hollow Reservoir) tournament seasons. Briefly, at each tournament a UCONN crew would establish contact with the tournament director and let him/her know that we were monitoring the tournament. Anglers were asked to bring their catch to the UCONN crew after their regular weigh in activities. Fish from each bag were held in a uniquely numbered holding pen that was immersed in lake water. UCONN agents asked each angler whether or not they culled out any tournament legal sized fish and how many anglers each bag represented. Each fish was measured for total length and given a fin clip unique to the 2014 tournament season. Each fish also received a full spine clip starting with the posterior dorsal spine and moving in the anterior direction. Recall that during the 2013 tournament season, fish were given a half dorsal spine clip starting at the anterior and moving towards the posterior of each individual. This allowed us to count the total number of tournament captures of each individual over the course of the 2013 and 2014 tournament season. Fish were then observed for any injuries related to angling and released.

Objective 2: compare genetic introgression of unfished and fished individuals in a fished reservoir

We collected age-0 Largemouth Bass from Bigelow Pond on 7/31/14, 9/3/14 and 10/9/14 using beach seining and boat electrofishing consistent with sampling methods and techniques used to collect age-0 Largemouth Bass in 2013. Individuals were measured for total length and weight. A small non-lethal fin clip was collected from each individual and stored in 95% ethanol, or held on ice until return to the lab where the sample was frozen.

During January 2015, adult individuals from WSR1 and Mansfield Hollow that were stocked into Bigelow Pond in April 2013 were genotyped at 10 microsatellite loci by JMH in the laboratory of Dr. Amy Welsh at West Virginia University (JMH committee member). Concurrently a subsample of age-0 Largemouth Bass collected in 2013 and 2014 were genotyped at the same 10 microsatellite loci, and a ten percent error check was conducted for all samples.

Objective 3: evaluate differences in basal metabolic rate and angling vulnerability of unfished and fished populations of bass raised in a common environment

During the summer of 2014 we conducted a standardized angling experiment to evaluate whether or not there were differences in angling vulnerability among exploited and unexploited populations of Largemouth Bass that were equally naïve to angling. This experiment was a follow up to the evaluations of basal metabolic rates that we conducted during fall 2013.

Standardized angling occurred three days a week during four randomly selected time periods (7-10 am, 10 am - 1 pm, 1 - 4 pm, and 4 – 7 pm). To ensure that angler effort was spread evenly around the pond, six fishing stations were established, two at either end of the pond, and two evenly distributed along each side of the pond. Each station was marked by a stake; anglers were permitted to move around the stake, but instructed to move no further than halfway to the next station. The starting position each day was randomly selected, and if two anglers were present, the second angler started at the position farthest from the first angler. Anglers then proceeded around the pond in a direction (clockwise or counter-clockwise) that was randomly selected. We employed three lures throughout the angling experiment: a 5 cm F5-Rapala crank bait, a Mepps Plain Aglia size 0 spinner bait, and a 1/16th oz white jig head fitted with a MisterTwister curly tail grub. At each station lures were presented in a predetermined random order, and fished for five minutes of actual fishing time each i.e., if a fish was captured and processed the five minute timer was stopped. When a fish was captured a stop watch was started to record handling time. For each captured fish we measured total length, weight, determined population of origin and clipped the anal fin and one dorsal spine (similar to our 2013 procedure at Gardner Lake tournaments) to facilitate the identification of recaptures. We also recorded the station at which the fish was captured, the time of day of capture and then released the fish. At the start and end of each day we recorded the pond's water temperature from the same location. Data were recorded on the weather conditions including cloud cover, air temperature, barometric pressure and humidity (the latter three downloaded from a weather station located roughly 1 km from the study site).

At the conclusion of the angling experiment we conducted a whole pond census on November 7th, 2014 to determine the number of individuals remaining in the pond and their capture history. This was important for determining the number of individuals that had never been captured by angling. For the census, the pond's water level was lowered by removing the stand pipe and repeated seine hauls were conducted through the remaining water until no fish were captured in three consecutive seine hauls. All captured fish were measured and weighed, their population of origin was recorded and their angling capture history was recorded. These individuals were held in an aerated tank until the census was complete, at which point they were returned to the pond.

Catch per effort (catch/hr) data were corrected for exploited and unexploited individuals each day based on the normalized abundance of individuals from exploited and unexploited populations at the start of the angling trial. The effect of exploitation status on catch per effort was evaluated using an analysis of covariance (ANCOVA). Catch per effort was the response variable, and cumulative catch events, population exploitation status, maximum observed water temperature (hereafter referred to as water temperature), the interaction between population exploitation status and cumulative catch events, and the interaction between population exploitation status and water temperature interaction were entered as predictor variables. We selected cumulative catch events as opposed to experiment day as our continuous covariate, because it integrates both the passage of time since the experiment began, and the number of opportunities fish had to experience capture directly or indirectly. Model assumptions were verified by examining the normal quantile plot and testing for differences in catch rate residuals among exploited and unexploited individuals. Statistical analysis was performed using program JMP v. 11, using an alpha value of 0.05 to determine significance. Data are reported as mean $\pm$ SD where appropriate.

Preliminary Results

Objective 1: Compare bass tournament catch rates between unfished populations of bass stocked into public lakes and resident fished populations

We monitored a total of 30 tournaments during 2014 in which 1,397 capture events occurred; 95% of captured individuals were Largemouth Bass, and 5% were Smallmouth Bass. A total of 944 unique Gardner Lake resident Largemouth Bass were observed at tournament weigh-ins during the 2014 season. Of those 944 fish, 747 were seen at only one weigh-in, 143 were seen at two weigh-ins, and 54 were seen at three or more weigh-ins (see Fig. 1). Analyses are underway to determine the number and capture history of unique Mansfield Hollow bass observed at 2014 weigh-ins. This analysis is complicated by the potential for transplanted Mansfield Hollow bass to have spine clips prior to their introduction to Gardner Lake (as a result of the 2012 tournament monitoring study at Mansfield Hollow).

Analyses combining the number of capture events based on tournament monitoring and creel surveys conducted by DEEP will facilitate estimates of the total catch-and-release fishing mortality in Gardner Lake and Mansfield Hollow Reservoir and impacts on population size structure. This analysis is expected to be completed by April 2015. Likewise a comprehensive analysis of all captured individuals across both systems and both sampling seasons will be completed by summer 2015.

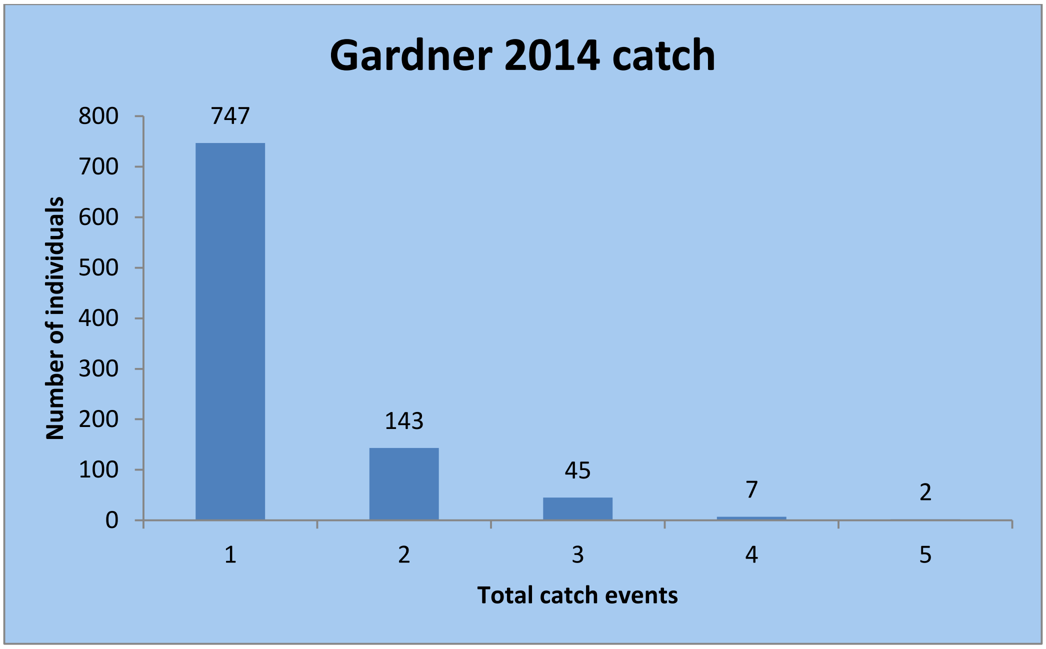

Figure 1. Number of unique resident Gardner Lake bass captured in one or more tournaments during the 2014 tournament monitoring season.

Objective 2: compare genetic introgression of unfished and fished individuals in a fished reservoir

A total of 77 WSR1 adults, and 79 Mansfield Hollow Reservoir adults that were stocked into Bigelow Pond in 2013 were genotyped at 10 microsatellite loci. Additionally 226 age-0 bass collected during the 2013 summer and fall, and 50 age-0 bass that were collected during summer and fall 2014 were genotyped. Additionally, 48 samples randomly distributed among the sample plates were re-run at all ten microsatellite loci representing an 11% random error check.

Allelic scoring and data checking are underway for this dataset and results are expected by May 2015. Once scored, data will be used to conduct parentage analysis of the age-0 bass collected during both seasons (see 2013-14 progress report for detailed parentage and population assignment methods).

Objective 3: evaluate differences in basal metabolic rate and angling vulnerability of unfished and fished populations of bass raised in a common environment

Experimental standardized angling began on July 14th 2014 and continued until September 29th 2014, resulting in 123 capture events representing 102 unique individuals (41 from exploited populations and 61 from unexploited populations). The total catch closely mirrored the estimated initial abundance of fish in the pond (61% unexploited and 39% exploited).

No significant differences in length (exploited mean = 176.5 $\pm$ 33.3 mm, unexploited mean = 172.9 $\pm$ 30.4 mm; P = 0.59) or weight (exploited mean = 84.9 $\pm$ 58.9 g, unexploited mean = 79.8 $\pm$ 48.4 g; P = 0.65) existed among exploited or unexploited individuals captured in this study. Mean handling time was 113 $\pm$ 10 s and did not differ significantly between exploited and unexploited individuals (P = 0.93). An ANCOVA analysis (Table 1) explained significant variation in catch rates ($F_{5,52} = 52.0$, P<0.001, $R^2_{adj} = 0.82$) and revealed that cumulative catch events had a significant negative effect on the overall catch rate ($F_{1,52} = 218.7$, P < 0.001). Likewise, water temperature also had a significant effect on overall catch rates, such that warmer days resulted in higher catch rates ($F_{1,52} = 13.6$, P < 0.001). Population exploitation status did not have a significant effect on catch rates ($F_{1,52} = 0.9$, P = 0.35), however, there was a significant population exploitation status by cumulative catch events interaction (F1,52 = 4.7, P = 0.04) indicating that catch rates of individuals from exploited populations decreased significantly faster than individuals originating from unexploited populations (Figure 2). Finally there was not a significant water temperature by population exploitation status interaction (F1,52 = 2.7, P = 0.10), indicating that catch rates responded to temperature independent of population exploitation status. A visual examination of the normal quantile plot of model residuals revealed no substantial departures from normality; and residuals were not significantly different among exploited and unexploited populations, indicating that model assumptions were met.

Table 1. ANCOVA table describing factors associated with the catch rates of the standardized angling experiment.

Source	df	SS	F	P
Cumulative catch	1	203.69	218.7	**<0.0001**
Status	1	0.82	0.9	0.35
Catch*Status	1	4.35	4.7	**0.04**
WaterTMax	1	12.66	13.6	**0.0005**
WaterTMax*Status	1	2.52	2.7	0.11

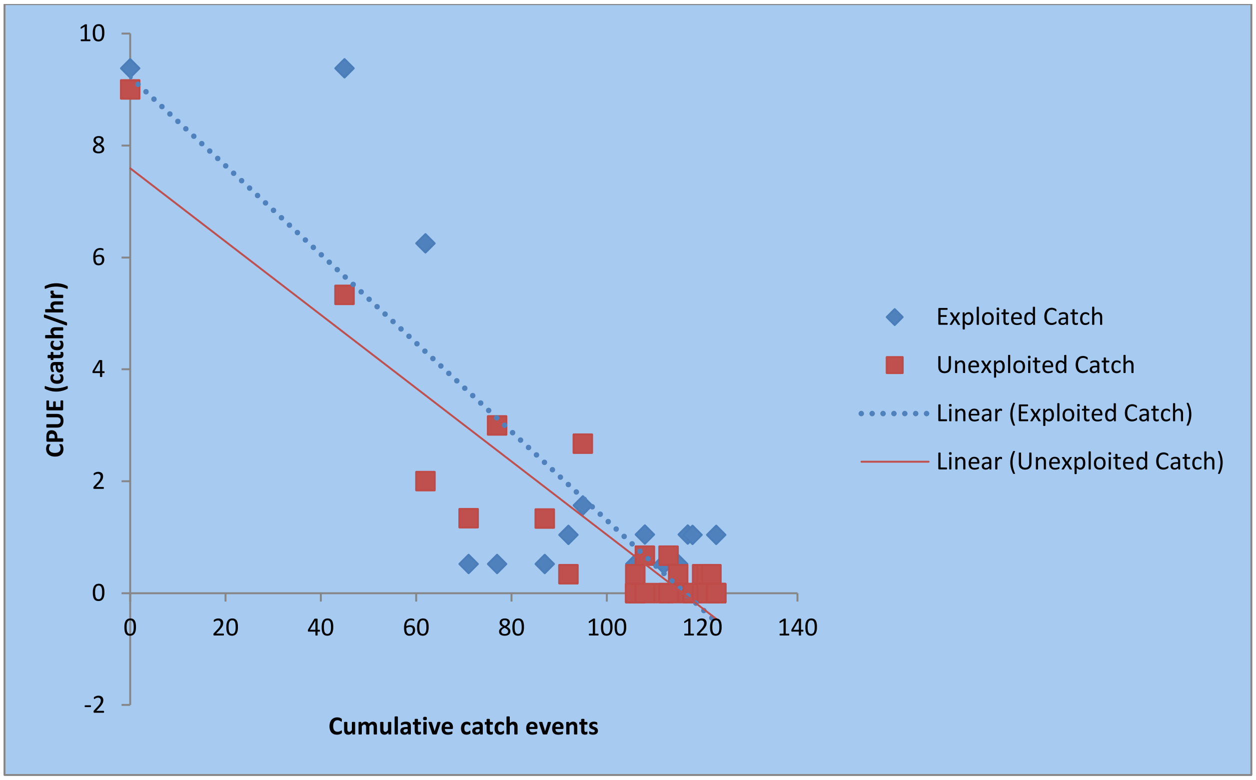

Figure 2. Catch per unit effort (catch/hr) for exploited individuals (blue diamonds) and unexploited individuals (red squares) versus the cumulative number of catch events that had occurred in the pond. Catch rates declined significantly faster for exploited individuals (blue dotted trend line) relative to unexploited individuals (red solid trend line).

In collaboration with DEEP we conducted a whole pond census on November 7th, 2014. A total of 155 fish were captured, representing all four initial populations (Amos Lake: N= 43; Gardner Lake: N= 22; WSR1: N= 52; WSR2: N= 38). Of the 155 fish captured, 29 individuals were known respirometry fish from our 2013 respirometry trials (see previous progress reports). Experimental angling captured 44% (N=69) of the individuals that were sampled during the census, with the number of captures ranging from one to three times during the course of the experiment (Figure 3). Further analysis associating the effect of population metabolic rates and angling vulnerability are underway and will be completed by early summer 2015.

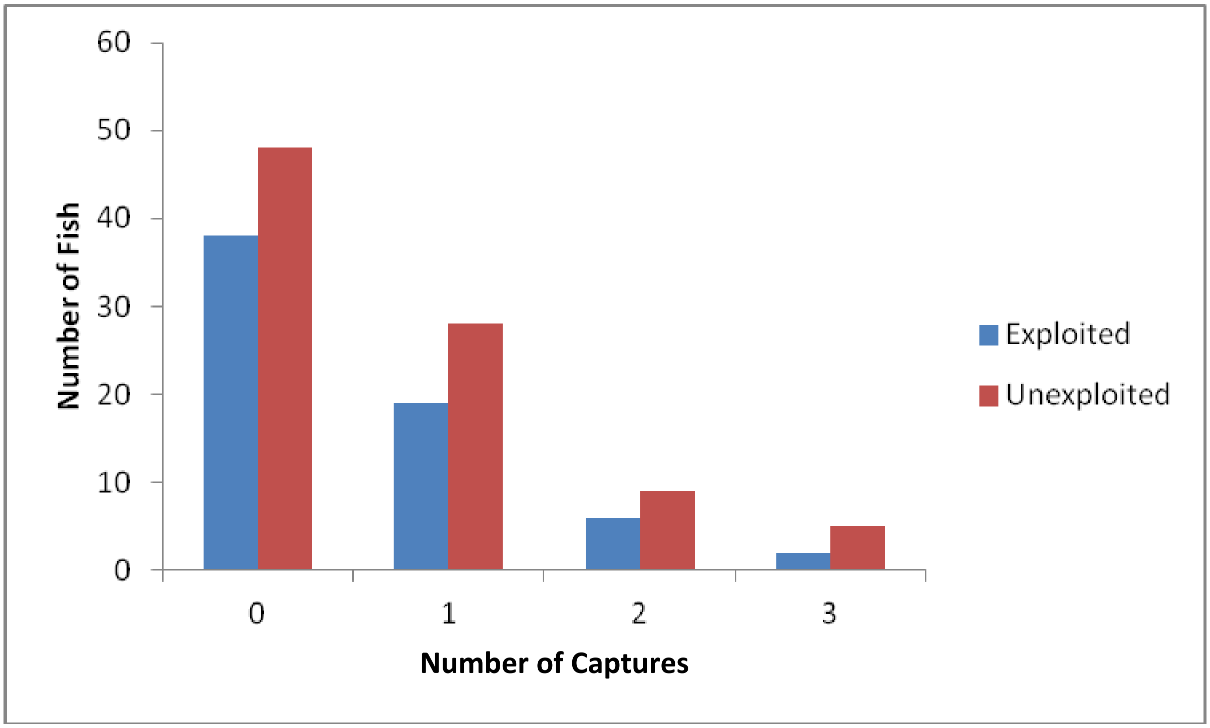

Figure 3. Angling capture history of exploited and unexploited Largemouth Bass stocks present during the census of Punch Brook Pond on November 7, 2014.